

CREATING CRATERS

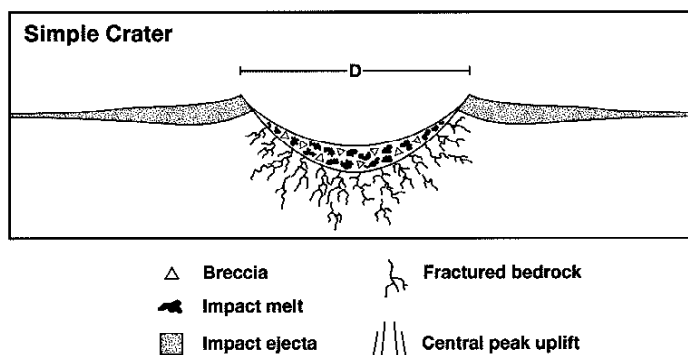
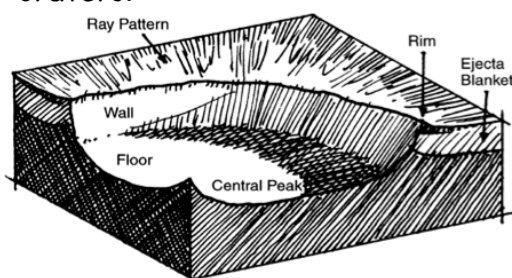
Crater Information:

Bolides or impactors are any falling body such as a meteorite and are commonly made of rock, ice, or a combination of rock and ice. When a bolide collides with a planet, it produces an *impact crater* (Figure 3.1). A crater's circular shape is due to material flying out evenly in all directions as a result of the explosion upon impact rather than as a result of the bolide having a circular shape. In fact, almost no bolides are spherical.



3.1 Impact Craters

Materials flung out at high speeds produce *rays*, straight lines radiating away from the impact crater. Materials flung out at slower speeds produce an *impact or ejecta blanket*, a layer of material, sometimes quite thick, immediately surrounding the crater. See the diagrams below for more information on the structure of craters.



Craters come in different sizes

The largest crater on Donner is the Hellas basin, which is roughly twice the size of Alaska. However, most impact craters found on Donner are smaller than 100 km.

Craters hint at the age of the surface

Scientists studying craters on Donner noticed that some areas have many craters while other areas have just a few. The generally accepted theory is that all areas on Donner used to be heavily cratered, and then surface changes such as lava flows, flowing water, or intense dust storms obliterated some of the craters, leaving a younger, smoother surface.

Craters hint at what's under the surface

The shape of an ejecta blanket depends on the characteristics of the surface hit by a impactor. Some craters on Donner have ejecta blankets. The mud-flow-like shape that surrounds the crater gives a clue about the nature of the surface. Scientists believe that the heat and pressure of an impact melted ice under the surface, forming mud.

Objective: In this lab, you will learn how craters form, observe their features, and analyze how the mass and velocity of the falling body affects crater formation.

Pre-lab Questions: Answer the following questions based on what you already know.

1. How do you think the mass of the falling objects affects the formation and size of the resulting crater?
2. How do you think the speed (velocity) of the falling body affects the size and formation of an impact crater?

Materials:

- Plastic dish
- Flour
- Chocolate Powder
- Electronic balance
- 3 impactors of differing masses and sizes – a marble, a bouncy ball and a ping pong ball
- Meter stick
- Plastic ruler

Procedure:

Part A – The Affect of Mass on Impact Crater Formation

1. Fill the tray with 3 cm of flour
2. Sprinkle a .5 cm layer of the chocolate powder, using enough to hide the flour.
3. Smooth the layer with a ruler, being careful not to mix the two layers
4. Use the electronic balance to find the mass of each of the three impactors you use. Be sure to tare the balance before each weighing and record the masses in the data table below.
5. Drop **Marble Impactor** from a height of 60 cm onto the prepared surface and measure the diameter of the crater (cm). Record your information in the table.
6. Draw your crater in the space provided on the next page and note the movement of the powder – it represents the ejecta from the impact. Record observations in the space provided. (how do the craters differ?)
7. Repeat steps 5-6 for the **Bouncy Ball Impactor** and the **Ping Pong Impactor**.

Note: You may need to smooth out your powder layers between drops!

Data Table 1

| Object | Object Mass(g) | Height of Drop(cm) | Crater Diameter (cm) |
|----------------------|----------------|--------------------|----------------------|
| Marble Impactor | | | |
| Bouncy Ball Impactor | | | |
| Ping Pong Impactor | | | |

Drawings and Observations: Draw your crater in the space provided and note the movement of the powder – it represents the ejecta from the impact. Record observations in the space provided. (how do the craters differ?)

Crater #1 – Marble Impactor



Crater #2 – Bouncy Ball Impactor



Crater #3 – Ping Pong Impactor



Observations:

Part B – The Affect of Velocity on Impact Crater Formation

1. Smooth the layer with a ruler, being careful not to mix the two layers. You may need to add more chocolate powder.
2. Drop the **BOUNCY BALL IMPACTOR** from a height of 30 cm onto the prepared surface and measure the diameter of the crater (cm). Record your information in the table.
3. Draw your crater in the space provided and note the movement of the chocolate powder – it represents the ejecta from the impact. Record observations in the space provided. (How do the craters differ?)
4. Repeat steps 2-4 by dropping the BOUNCY BALL IMPACTOR from heights of 60 cm and then 90 cm.
5. You must also calculate the velocity for each of the 3 drops using the equation below.

$$v = \sqrt{2gh}$$

v = velocity (cm/s)

g = gravity (on earth, this is 980 cm/s²)

h = height (cm)

Data Table 2 – USE BOUNCY BALL IMPACTOR

| Drop | Object Mass (g) | Crater Diameter (cm) | Velocity (cm/s) |
|----------|-----------------|----------------------|-----------------|
| 1. 30 cm | | | |
| 2. 60 cm | | | |
| 3. 90 cm | | | |

Drawings and Observations:

Draw your crater in the space provided and note the movement of the powder – it represents the ejecta from the impact. Record observations in the space provided. (how do the craters differ?)

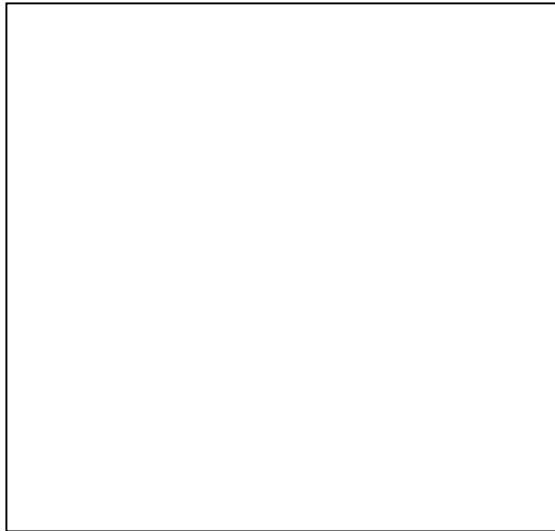
Crater #1 – 30 cm



Crater #2 – 60 cm



Crater #3 – 90 cm



Observations:

Calculations and Conclusions

Kinetic Energy (KE) is the energy of an object in motion. This energy depends on the mass (g) and velocity (cm/s) of the object, in this case an impactor. After an impactor hits the surface of Donner, the kinetic energy equals zero because the object is no longer in motion and the kinetic energy that the impactor carried is converted into other forms of energy. However, we can calculate the kinetic energy of the impactor before it hits the planet using the equation below.

$$KE = \frac{1}{2} mv^2$$

KE = kinetic energy (J)

m = mass (g)

v = velocity (cm/s)

1. Calculate the Kinetic Energy for the all three drops in Part 2. Which drop had the highest KE?

2. In Part 2, did the crater with the highest kinetic energy make the crater with the largest diameter? How does kinetic energy relate to diameter?

3. When an impactor hits an object, the kinetic energy is transferred into different types of energy. What types of energy may result from an impact and what effects does this energy have on the impact site?

4. What do the data reveal about the relationship between crater size and the mass of the impactor? How do your results compare to your initial hypothesis?

5. What do the data reveal about the relationship between crater size and the velocity of the impactor? How do your results compare to your initial hypothesis?

6. Based on your results from Parts 1 and 2, what combination of the variables will produce the largest impact crater?